THE MELANCONIALES*

By C. W. Edgerton

The Melanconiales, one of the orders of the large group of fungi generally known as the *Fungi Imperfecti,* consists of more than forty genera and several hundred described species. These are microscopic forms and many of them are as yet but little known to science. The genera in this group, as well as in the other groups of the imperfect fungi, are generally spoken of as "form" genera because the species, for the most part, are but the conidial stages of some of the higher fungi such as the ascomycetes. As the perfect or sexual stages are either not known or but rarely seen, it is necessary to classify these forms by the stages that commonly develop. And this results in a classification which is strictly artificial, many forms which would be widely separated in a natural classification being placed side by side in the "form" genera.

This group of fungi is a very important one both from the economic and scientific standpoints, and doubtless will interest some. Our lack of knowledge of many of the forms, however, makes the presentation of the subject rather difficult and all that can be done is to briefly describe a few of the species that are common in this country and also note the various problems which make the group particularly interesting.

Collection of Material for Study

The majority of these fungi are parasitic on higher plants, producing leaf spots, lesions on the stems, or rots of the fruits.

*This article is written by request. It is not meant to be technical in any way, it being the desire of the author to treat the subject in such a way that it will interest the teachers and students of biology in some of these lower forms of plant life that are usually not known outside of the larger colleges and universities. Our knowledge of many of these forms is not very definite and it would be impossible at the present time to enumerate and describe all the forms that are known to occur in this country. In this article, an attempt has been made to describe the more important genera and also to describe briefly a few of the more common species. In the genera, Gloeosporium and Colletotrichum, more species have been enumerated than in the other genera, as more work has been done with these and our knowledge is more definite.

Many of them are very common and it is not usually difficult to pick up some of them. The spots or lesions, however, are not usually distinct from those caused by other parasitic fungi and it is not always possible to be sure of one of them in the field, especially by a person who has not had much experience in collecting them. After a person becomes better acquainted with some of the different forms, he can often tell whether a fungus belongs to this group by means of a good hand lens, though he can not always be sure. For the beginner who wishes to become acquainted with this group, leaves showing dead areas or spots, stems with blackened or sunken lesions, and fruits or vegetables with spots or rots should be collected. These can be brought into the laboratory and studied.

Examination and Study of Material Collected

For the examination of the material, a good microscope with 2/3 and 1/6 objectives, a good hand razor, a few spear shaped needles, and a few moist chambers are necessary. Thin cross sections through the fruiting pustules should be made with the razor and these should be mounted in water and examined. With the low power objective, the characters of the fruiting pustule can be made out and one can readily tell whether the fungus belongs to the Melanconiales or some other order. For the study of the other characters such as the spores, coniliophores, and setae, the high power objective is necessary. A person who has studied the group for some time can generally tell whether a fungus belongs in this group or not by merely scraping off some of the pustules and examining them in a crushed mount. He is able to do this, however, because he knows the shape and appearance of the spores and setae. If there is anything peculiar in the mount, he must also make sections for examination.

These crushed mounts or sections can be preserved by running a little 50% glycerin tinted with eosin under the cover slips. These preserved mounts are often very useful for comparison when other forms are collected.

Often material that is brought in from the field shows the fungus only partially developed, or else the spores have all been washed off by recent rains. If the material is in this condition, it can be placed in a moist chamber for a day or so and examined again.

Many of the forms will develop well in this manner. Often also the moist chamber comes in handy in preserving the material over night or even longer when an immediate examination is impossible.

If a thorough study is being made of any of these fungi, microtome sections are often not only helpful but essential. With these, the development of the pustules, the finer characters of the conidiophores and underlying stroma, and the condition of the diseased host cells can be made out. For a killing solution, the writer generally uses Gilson's Fixing Solution*. This is an alcoholic solution and the spores are held in place in the pustules. With the aqueous fixing solutions, the spores are generally washed out of the pustules. Any of the ordinary stains can be used, the writer generally using Iron Alum Haematoxylin with Congo Red as a counter stain.

Culture of the Fungi

A great deal can be found out concerning these fungi by merely examining the material collected in the field, but if this can be supplemented with some culture work, the study will become more interesting and instructive. If some of the apparatus and materials of the bacteriological laboratory are available, such as sterilizers, petri dishes and test tubes, the fungi should be cultured and their growth watched. Most of the fungi grow well on any of the ordinary culture media, though media made from potato tubers, bean pods, or corn meal are perhaps the best. These forms can be isolated by either making dilution cultures with the spores, or by transferring some diseased material from the host plant after the outside tissues are stripped off or cut away with a sterile knife. A large majority of these fungi grow and fruit well on culture media.

The Orders of the Imperfect Fungi

In the classification of most plants, whether high or low in the plant kingdom, the characters of the sexual stage are generally used, but in the *Fungi Imperfecti,* the sexual stages are so often unknown or so infrequently seen, that other characters must be used. As the conidial stage of these forms is the one most often

*Gilson's fixing solution: 95% alcohol 42cc., water 60cc., glacial acetic acid 18cc., nitric acid (conc) 2cc., corrosive sublimate (sat. sol.) 11cc. The material is left in the fixer 6-24 hours and washed directly in 70% alcohol.

seen, the characters of this stage are the ones which must be used if the fungi are to be satisfactorily separated and classified.

The *Fungi Imperfecti* are divided into three orders, the characters of the conidial fructifications being the ones that are used to separate them. These orders are as follows:

Sphaeropsidales. In this order, the conidia are borne on simple or branched conidiophores within pycnidia or within cavities in a stroma. The pycnidia are quite variable in shape, size, texture, and color, and they may be open to the surface by an ostiole or they may be entirely closed.

Melanconiales. In this order, the spores are borne on short, simple or branched conidiophores which arise from a more or less well developed stroma. The fruiting pustule, or acervulus, consisting of the stroma, conidiophores, and spores, usually develops underneath the spidermis or cortex of the host plant and later breaks through to the surface, though this is not always the case.

Hyphomycetes. In this group, the conidia are borne in various ways, but generally on conidiophores arising directly from the mycelial threads. This group includes all of the forms that cannot be classified in the first two orders.

The Acervulus

As can be seen, the presence of the acervulus is the one distinguishing character of the Melanconiales. Beyond this one character, there is nothing common in the group. And as the acervulus is not a definite structure, it is not always a good separating character. Forms exist which are more or less on the boundary line between the Melanconiales and the Sphaeropsidales, and also between the Melanconiales and the Hyphomycetes. Furthermore there are forms which could be placed in two of the orders and some in even all three, as different methods of spore development occur at different times in their development.

The shape and appearance of the acervulus varies considerably even within the same species. Figures 1 and 2 represent two types which often occur. Figure 1 was drawn from sections from a tomato that was affected with a Gloeosporium, while figure 2 was from an apple also affected with a Gloeosporium. This difference, however, is not a specific one as both types frequently develop on

the same host. Figure 2, as a rule, represents an older condition than figure 1. These figures show the main characteristics of the

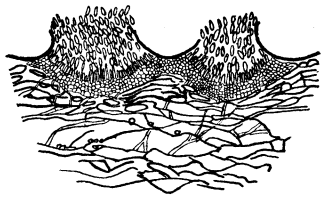

FIG. 1

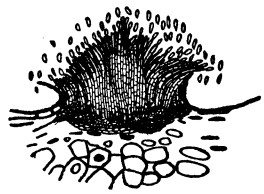

FIG. 2

Fig. 1. Acervulus of *Gloeosporium fructigenum* from the fruit of tomato
Fig. 2. Acervulus of *Gloeosporium fructigenum* from apple.

acervulus of any of the genera, showing the ruptured epidermis, the fungus stroma at the base of the acervulus and the conidiophores and spores.

While all of the members of the Melanconiales develop the spores in acervuli, this does not mean that they are related. There are many forms possessing this structure which are known to be widely separated and would be placed in widely separated groups if a natural classification were used. Many have looked on it as peculiar that these divergent forms would have the same method of conidial formation. But when we study the development of the acervulus and understand its probable origin, it does not seem so peculiar. It is certain that these fungi did not all originate from a common form and it must follow that this method of fruiting must have been developed by a number of different forms independently.

All of these fungi which grow within the tissues of higher plants, must be able in some way to come to the surface for spore formation. The single mycelial threads of most of them are unable to rupture the epidermis of the host plant and some other method must be used. In the Melanconiales, a number of fungus threads develop underneath the epidermis, form a fungus stroma, and begin to produce a dense layer of short conidiophores. While a single fungus thread can not develop a great deal of strength by itself, this whole mass of fungus tissue by an outward growth, can exert enough strength to rupture the epidermal or cortical tissue and thus come to the surface for spore formation. There is no great regularity about these acervuli in shape and size or in the amount of stromatic tissue developed; in fact an acervulus is really nothing

but a rather dense mass of fungus tissue and not a definite fruiting body as this term is applied to other forms of fructification. Knowing the structure and development of the acervulus, it is then not difficult to understand why so many different forms have this method of spore production. This form of fruiting is very simple, and perhaps is the easiest method which could be developed by the forms which grow within the tissues of living plants. The mere fact that many of these forms will grow like hyphomycetes producing the spores directly on the mycelium when there is sufficient moisture to allow them to grow on the surface of the culture medium or affected plant, shows that the acervulus is not always a definite structure but rather a development of tissue to bring the fungus to the surface.

The Perfect Stages

A number of species of the Melanconiales have been shown in recent years to have ascogenous stages in their life history. Strictly speaking, these forms should not be considered as members of this order and should be classified among the ascomycetes, but for the sake of convenience, they are still often considered as members of this group. The perfect stages are only rarely seen, and if an attempt is made to determine a species, it must be done with the imperfect characters alone.

Some of our most important and common forms of this order are now known to have ascogenous stages. In some of these, the ascomycete fructification develops as a winter stage, that is, it develops on the dead portions of the host plant during the winter months. Examples of such forms are the Gloeosporiums from the sycamore and currant, the Marssonia from the walnut, and the Myxosporium from the dogwood. In other forms, the season seems to have nothing to do with the development of the ascogenous stage, this being developed along with the conidial or immediately following it. This group includes many of our common Gloeosporiums and Colletotrichums such as are found on apples, cotton bolls, etc.

Many different ascogenous genera have been connected with different members of the Melanconiales, and many of these are

widely separated in our present classification of the ascomycetes. Among these are the following:

Gnomonia, connected with forms in the genera Gloeosporium and Marssonia.

Glomerella (figure 3), connected with forms in the genera Gloeosporium and Colletotrichum.

Pseudopeziza, connected with a Gloeosporium.

Neofabrea, connected with a Gloeosporium.

Sphaerella, connected with a Gloeosporium.

Diaporthe, connected with forms in the genus Myxosporium.

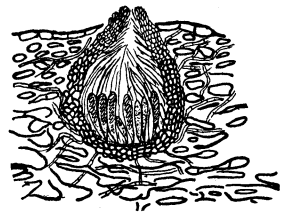

FIG. 3

Fig. 3. *Glomerella gossypii,* the perfect stage of *Colletotrichum gossypii.*

Many other ascogenous forms have also been found growing with members of the Melanconiales, and the probability is that they are connected, though the absolute proof is still wanting. Among these are the following:

Trochila, with forms in the genera Gloeosporium and Marssonia.

Anthostomella, with Myxosporium species.

Pseudovalsa, with Coryneum species.

While there are doubtless other ascogenous genera connected with forms in the Melanconiales, these are sufficient to show that this group is made up of a large number of widely related forms, and that the classification does not show relationship among them.

Characters of the Genera

According to Engler and Prantl, there are forty-six genera in the order Melanconiales. These are separated mostly on spore characters, though other characters such as the presence or absence of setae, or the presence or lack of branching of the conidiophores are sometimes used. A great number of these genera, however, are

not important. Many of them have only from one to a few species and these are very rare. Many of them are also but very little known. There are only about eight genera that are really important and common and these only will be considered in this article. A key for distinguishing these genera follows:

I. Conidia hyaline, one-celled, globose to oblong.
  1. Fungi generally growing on leaves, fruits or tender stems.
    (1). Acervuli with but few or no setae.....Gloeosporium.
    (2). Acervuli with setae, generally abundant..Colletotrichum.
  2. Fungi generally growing on woody branches or trees or shrubs.
    (1). Spores straight or slightly curved.....Myxosporium.
II. Conidia dark, one-celled, globose or oblong, solitary on the conidiophores ..... Melanconium.
III. Conidia hyaline, two-celled, fungus growing on leaves.....Marssonia.
IV. Conidia dark, two to several septate, oblong to cylindric.
  1. Condia with cilia or appendages at the apex.....Pestalozzia.
  2. Conidia without cilia, oblong or elongate.....Coryneum.
V. Conidia hyaline, long filiform, generally continuous....Cylindrosporium.

As may be seen from the key, the characters separating some of the genera are not clear cut and distinct. The differences between Gloeosporium and Colletotrichum, or Gloeosporium and Myxosporium are not always clear. In fact, some individual species may be placed in any one of the three genera. However, as most of these forms will finally be placed in the genera of ascomycetes to which they really belong, their position among the imperfect fungi is not really important.

Specific Differences

Before taking up the common species of the Melanconiales, it may be well to call attention to some of the difficulties ahead of the person who tries to determine these forms accurately. Up until the past few years, botanists as a rule determined the species in this group to a large extent by the hosts upon which they were found growing. If a form was found on a new host, it was usually determined as a new species. While some of these forms possess morphological characters that distinguish them from other species, we have a large number of others which cannot be told apart by morphological characters. During the past few years, a number of botanists have been working on this group and it has been found that a number of these described forms are identical. This has

been proven by cross inoculation experiments. It has also been found that some forms, though morphologically very similar to others, cannot be successfully inoculated into the hosts of the other forms. This makes them distinct from a physiological standpoint at least. Whether these should be considered as good species is still an undecided question. In this article, these forms are left as distinct species and they are separated from each other by host characters alone.

Furthermore, a person is liable to pick up forms, especially from the genera Gloeosporium and Colletotrichum, which do not seem to be described, or at least are not described from the host on which he found them. It is difficult to determine these beyond the genus and it is perhaps better not to try to determine the species, as it is almost impossible to make sure of their identity without carrying on cross inoculation experiments.

In this article, only the common and better known forms are included. It is possible that all of these are not good species, but it seems better to keep them separate until they are proved to be identical with other forms.

THE GENUS GLOEOSPORIUM

The genus Gloeosporium, with some 400 described species, is the largest one of the order, and contains many forms which are very common. Some of our worst diseases of plants are produced by members of this genus, the loss produced by them running up into millions of dollars each year.

In this genus, the acervuli generally develop underneath the epidermis or cortex of leaves, stems, or fruits and become erumpent. The spores are hyaline and either straight or curved. They are typically one-celled, though some two-celled spores are met with in some of the forms. The conidiophores are short and much crowded. A few setae are sometimes present, though usually not abundant.

There are a number of very common forms and a large number which are not well known. Besides the described forms there are a large number of others on various hosts, some of which are distinct enough to be good species. The forms commonly met with in this country follow:

Key to the Species of the Genus Gloeosporium

I. Spores straight or nearly so, oblong or cylindrical.
  1. Spores relatively large, usually more than 10μ in length.
    (1). Spores exuding from the acervuli in slimy pink masses.
      a. Found on apple, pear, quince, grapes, fig, tomato, pepper, sweet pea, maple leaves, raspberry canes, and perhaps other fruits and stems. *G. fructigenum.*
      b. Found on greenhouse plants, very close to the preceding species and perhaps identical...*G. cinctum.*
      c. Found on privet, very close to preceding species. ..... *G. cingulatum.*
    (2). Spores in mass some other color than pink.
      a. Found on sycamore and oaks; ascogenous stage, Gnomonia.....*G. nervisequum.*
  2. Spores smaller, generally less than 10μ long.
    (1). Found on blackberry and raspberry canes....*G. venetum.*
    (2). Found on fruit and branches of grape..*G. ampelophagum.*
    (3). Found on cranberry fruit.....*G. minus.*

II. Spores more or less curved.
  1. Found on clover and alfalfa; spores fusoid.....*G. caulivorum.*
  2. Found on currant leaves; spores sickle shaped; ascogenous stage, Pseudopeziza.....*G. ribis.*
  3. Found on branches and fruits of apple in the northwest; spores decidedly curved; ascogenous stage, Neofabrea. .....*G. malicorticis.*
  4. Found on cactus in the southwest; spores lunate; ascogenous stage, Sphaerella.....*G. lunatum.*

Description of Common Species

Gloeosporium fructigenum Berk. This fungus is quite common on a large number of hosts though perhaps more frequently seen on the apple. The loss caused by this fungus is very great. The fungus attacks the fruits, branches and leaves of the different hosts. Affected fruits show spots or a general decay; affected stems, cankers or lesions; and affected leaves, either spots or a general blight. The acervuli develop as little papillae over the surface of the diseased portion of the host plant. The spores are produced very abundantly and ooze out of the acervuli in slimy pink masses. They are oblong to cylindric, often slightly narrower near the center than towards the ends, hyaline, one-celled, and about 12-20 x 4-6μ in size. When fresh, a clear nucleus is generally seen near the center of the spore. A few scattering setae are also some-

times present in the acervuli. The ascogenous or perithecial stage develops occasionally along with the conidial stage on the host or immediately following it, and it develops quite commonly on artificial media in pure cultures. The ascospores are generally slightly curved but in other ways they are very similar to the conidia. Since the discovery of the perfect stage, the fungus has gone by the name of *Glomerella fructigena* or *Glomerella rufomaculans*; the former name being the correct one according to our present rules of nomenclature.

Gloeosporium cinctum B. & C. This fungus is found on orchids and other plants commonly grown in greenhouses. The morphological characters are practically identical with the preceding species and it is possible that the two are the same. However, not enough cross inoculation experiments have been carried on to make perfectly sure of their identity and it seems better to leave them separated. The ascogenous stage is often seen and is now known as *Glomerella cincta* (Stoneman) Sp. & v. Schr.

Gloeosporium cingulatum Atk. This fungus grows on the smaller branches of privet, causing them to die and blight. The characters of the conidial and ascogenous stages are practically identical with *Gloeosporium fructigenum*. Since the discovery of the ascogenous stage, the fungus has been known as *Glomerella cingulata* (Stoneman) Sp. & v. Schr.

Gloeosporium nervisequum (Fuckel) Sacc. This species is quite common on sycamore and oaks of the species, *alba, velutina,* and *coccinea*. On these trees, it occurs both on the twigs and leaves. On sycamore leaves, it first attacks the tissue along the veins, causing it to turn brown and die. It was from these dead strips along the veins that it received its name. It also affects the young twigs and kills them, causing the leaves to wilt and die. The oak leaves, as a rule, are affected in spots, though occasionally the disease runs along the veins. In all of the affected tissue, the acervuli develop abundantly. The acervuli are light in color and from 100-300μ in diameter. The conidia, which are about 10-14 x 4-6μ in size, develop in abundance on the conidiophores and in moist weather or when the leaves are placed in moist chamber ooze out of the acervuli in creamy white masses or strings. On the twigs, the acervuli

develop in a similar manner to those on the leaves. This stage on the twigs, if it were the only one known, would place the fungus in the genus Myxosporium, where it has been described as *Myxosporium valsoideum* (Sacc.) All., and *Myxosporium platanicolum* E. & E. The ascogenous stage which develops on the old leaves on the ground during the winter months, is known as *Gnomonia veneta* (Sacc. & Speg.) Kleb. The characters of this stage are very different from those of Glomerella, the ascospores being two-celled, with one of the cells several times as large as the other.

Gloeosporium venetum Speg. This fungus occurs on the leaves and canes of blackberries and raspberries and is quite common in the northern states where it often does considerable damage. The disease appears in the form of spots on the canes, these at first being purplish in color but later become grey and sunken. On the leaves, small dead spots develop. The acervuli, which form quite abundantly in the older spots, are small, averaging about 50-150μ in diameter. The spores are hyaline, one-celled, and small, generally only about 6-8μ long. The fungus grows very poorly on artificial media and is not always easy to isolate. The 4-7 x 3-4μ. The ascogenous stage is not known.

Gloeosporium ampelophagum (Pass.) Sacc. This fungus occurs on the fruit and twigs of the grape and is well distributed throughout the United States. On the fruit, sunken spots develop which have more or less of a bird's eye appearance. The central paler portion of the spot is surrounded by a reddish zone which is generally quite characteristic. On the twigs, the spots are similar to those on the fruit, except that they are elongated in the direction of the main axis of the twig. The acervuli develop quite abundantly over the surface of the spots. The spores are hyaline, generally elliptical to oblong in shape, and small, usually about 4-7 X 3-4μ. The ascogenous stage is not known.

Gloeosporium minus Shear. The fungus occurs sparingly on the leaves and fruit of the cranberry. Definite spots are not formed, though the tissue is slightly brown around the acervuli. The acervuli are small and scattering. The conidia, which are about 6-9 X 3-4μ in size, form in a pale pinkish glutinous mass at the top of the acervulus. No ascogenous stage is known.

Gloeosporium caulivorum Kirchner. This fungus is quite abundant on clover in certain sections of the United States, especially in the West Virginia-Pennsylvania region. Long, dark colored, sunken spots develop on the stems and petioles of the host, these often causing the death of the portions of the plant above. The small acervuli develop abundantly in the sunken spots. The conidia are hyaline, cylindrical to fusoid, curved, and 12-22 x 3.5-5.5μ in size. No ascogenous stage is known.

Gloeosporium ribis (Lib.) Mont. & Desm. This fungus occurs quite abundantly on leaves of the cultivated currant in various parts of the United States and often does considerable damage by defoliating the plants. The dead spots which develop on the leaves are brownish to blackish with a somewhat lighter center and are generally about 1-2 mm. in diameter. The acervuli develop on the upper side of the leaf. The spores (Figure 4) are hyaline, one-

FIG. 4

Fig. 4. Spores of *Gloeosporium ribis*

celled, sickle-shaped, and are about 15-20 x 6-8μ in size. They ooze out of the acervuli in small light colored masses. The ascogenous stage has been found and is now known as *Pseudopeziza ribis* Kleb.

Gloeosporium malicorticis Cordley. This species occuring on fruit and branches of the apple in the north Pacific states, often does considerable damage, causing perhaps the worst disease of apples in that section. On the branches and twigs, the disease does the most damage as it causes the formation of large cankers followed by the death of the portions of the host above the parts affected. The cankers are slightly darker in color than the healthy portions and somewhat sunken. On the fruit, the fungus causes the development of light brown rotten spots which may gradually spread over the whole surface. On both the wood and the fruit, the acervuli develop and produce spores in abundance. The spores are very striking in appearance on account of their shape. Some of them are bent into nearly a complete circle. The ascogenous

stage has been found and described as *Neofabrea malicorticis* Jackson.

Gloeosporium lunatum E. & E. This species occurs abundantly on certain species of cactus in the southwest, forming circular spots 1-3 cm. in diameter. The acervuli are abundant, 60-125μ in diameter. The conidia are lunate fusoid, 12-20 x 2-3μ, often one septate. This species is not a typical Gloeosporium on account of the spores being often septate. Possibly the genus Marssonia would fit it better than Gloeosporium. However, the ascogenous stage has been found, and the genus to which the conidial stage belongs is not really important. The ascogenous stage has been described as *Sphaerella opuntiae* E. & E.

THE GENUS COLLETOTRICHUM

The genus Colletotrichum, with some 80 or more described species, is very similar to Gloeosporium. The only difference between the two genera is in the abundance of setae in the acervuli. The species in this genus seem to fall into groups; those with straight spores and those with curved spores. Many of the straight spored forms are very closely related to *Gloeosporium fructigenum,* perhaps some of them being identical. The forms with curved spores, however, are very distinct. This genus also contains some very bad disease producers, nearly all of those described below causing serious trouble. Mention will only be made of the more common described forms, and these will be separated by the hosts upon which they are found growing, as it is impossible to separate them by morphological characters.

Key to the Commoner Species of Colletotrichum

I. Spores straight or nearly so.
   1. Found on cotton in southern states.....*C. gossypii.*
   2. Found on watermelon and cucumber.....*C. lagenarium.*
   3. Found on bean.....*C. lindemuthianum.*
   4. Found on clover and alfalfa.....*C. trifolii.*
   5. Found on snapdragon.....*C. antirrhini.*
   6. Found on citrus fruits.....*C. gloeosporioides.*

II. Spores curved.
   1. Found on sugar cane.....*C. falcatum.*
   2. Found on Johnson Grass, sorghum, and related plants..*C. lineola.*
   3. Found on grasses and cereals.....*C. cereale.*

Description of Common Species

Colletotrichum gossypii Southworth. This species is found on the various parts of the cotton plant, though it is seen more frequently on the bolls. It at first produces sunken discolored spots on the bolls, but these generally increase in size so that a general rot is produced. The spores are produced very abundantly in the acervuli, often the whole surface of the spot being covered with a slimy pink mass of them. The spores (Figure 5) which are identical with those of *Gloeosporium fructigenum,* develop both on the

FIG. 5

Fig. 5. Spores and setae of *Colletotrichum gossypii*

conidiophores and setae. The setae are usually abundant. The ascogenous stage has been found and is now known as *Glomerella gossypii* Edg.

Colletotrichum lagenarium (Pass.) Ell. & Hals. This fungus is found on the fruits and leaves of such plants as cucumbers and watermelons. Watersoaked, sunken spots which later become covered with the slimy spore masses, form on the fruits and often ruin them. The morphological characters of this fungus are practically the same as those of *Gloeosporium fructigenum.* No ascogenous stage has as yet been found.

Colletotrichum lindemuthianum (Sacc. & Magn.) Scrib. This fungus, found on the pods and leaves of the cultivated bean, causes the much dreaded bean anthracnose disease. Large, sunken, dark colored, slimy ulcers develop on the bean pods rendering them worthless. Morphological characters of the fungus quite similar to *Gloeosporium fructigenum,* the main difference being the darker color of the bean fungus. Physiologically, however, this fungus is quite distinct. The ascogenous stage, belonging to the genus Glomerella, has been found in pure cultures but it has not been named.

Colletotrichum trifolii Bain. This fungus forms dark colored spots on the stems and petioles of clover and alfalfa, often doing a

great deal of damage. Morphological characters similar to *Gloeosporium fructigenum*. The ascogenous stage has been reported but has not been described or named but probably belongs to the genus Glomerella.

Colletotrichum antirrhini Stewart. This fungus occurs on the cultivated snapdragon and some related wild plants producing dark colored lesions on the stems and petioles. Morphological characters similar to *Gloeosporium fructigenum*. The ascogenous stage has as yet not been found.

Colletotrichum gloeosporioides Penz. This fungus, found on various citrus fruits such as oranges, lemons, and pomelos, produces a disease of the fruits, leaves, and twigs. Spots are formed on the fruits which are often followed by a general rot. The leaves are either affected in spots or along the margins. The twigs are also killed back from the tips. The morphological characters of the fungus are similar to those of *Gloeosporium fructigenum*. No ascogenous stage has been reported.

Colletotrichum falcatum Went. This fungus is found on the leaves and stalks of sugar cane in the southern states, where it often does considerable damage. Spots up to one to two feet long develop on the midribs of the leaves. These spots are at first red in color but later turn to white or gray at the center. The fungus also grows on the inside of the cane stalk. The tissue is at first turned red but later horizontal white spots appear within the red. The fungus fruits abundantly on the older spots on the leaves and occasionally on the stalks. To the naked eye, the acervuli appear as small black pustules. The acervuli always contain setae in abund-

FIG. 6

Fig. 6. Spores of *Colletotrichum falcatum*

ance. The spores (Figure 6) are hyaline, curved, somewhat pointed at one end and more rounded at the other, 24-32 x 6-7μ. The spores when fresh show a clear nucleus near the center. No ascogenous stage has been found.

Colletotrichum lineola Corda. This fungus is found on the leaves and to some extent on the seeds of such plants as Johnson grass, broom corn and sorghum. Bright red spots develop very abundantly on the leaves, these being covered with the black acervuli. Morphological characters are very similar to those of *Colletetrichum falcatum,* though this fungus cannot be satisfactorily inoculated into sugar cane. No ascogenous stage has been found ious cereals and grasses in various sections of the United States as yet.

Colletotrichum cereale Manns. This fungus is found on var- affecting various parts of the host plants, though perhaps more common in the flowering parts. It often causes a shrinkage and shriveling of the grains. The morphological characters of the fungus are very similar to those of *Colletotrichum falcatum,* though the fungus is probably physiologically distinct. No ascogenous stage has as yet been found.

THE GENUS MYXOSPORIUM

The genus Myxosporium, with about 90 described species, contains a few species that are fairly common in the United States. The characters distinguishing this genus from Gloeosporium are not always clear cut. The Myxosporium species generally grow on woody branches, while the Gloeosporium species on fruits, leaves, and tender branches. But there are a number of species which grow on both woody branches and fruits, such as *Gloeosporium fructigenum* and *Gloeosporium malicorticis.* It seems best to restrict the genus Myxosporium to those forms that grow only on woody branches. Some of the species of Myxosporium are parasitic while others are only saprophytic.

In the genus Myxosporium, the acervulus usually develops underneath from one to several layers of cells of the host plant and then becomes erumpent. The conidia, which are one-celled, hyaline, and straight or slightly curved, are produced singly on the short, simple crowded conidiophores. There are a few well known species and many that are but little known. As only a few of these forms will be mentioned, no attempt will be made to separate them by a key.

Description of Species

Myxosporium corticolum Edg. This fungus occurs very abundantly on branches and trunks of apples and pears in the northeastern states. It is principally a disease of the bark tissue and does not extend to the cambium. Slightly sunken cankers are formed which are at first smooth but later become cracked and checked. The acervuli, which are about 1-2 mm. in diameter, develop under four or five layers of bark cells. The spores are straight, cylindrical, hyaline, 18-32 x 6-9μ. These ooze out of the acervuli in white strings or masses.

Myxosporium coloratum (Peck) Sacc. This fungus is found is found on the branches of the yellow poplar (Liriodendron). It is a very striking species as the spores ooze out of the acervuli in reddish masses. The acervuli are small and appear as little papillae over the surface of the bark. The spores are hyaline, straight or curved, 12-18 x 5-8μ.

Myxosporium nitidum B. & C. This fungus is found on the branches of dogwood (*Cornus alternifolia*) and is very common in the northeastern states. The acervuli are small, about 40-60μ, but abundant on the dead portions of the host, appearing as small yellow papillae. They develop under several layers of the host cells. The spores, which are hyaline, straight, 9-12 x 3-5μ, are produced very abundantly and ooze out in yellow masses. The ascogenous fungus *Diaporthe albocarnis* E. & E. appears on the diseased twigs in the late winter and, as has been proven by some cultural experiments, belongs to the Myxosporium.

Myxosporium ulmi (Oud.) Sacc. This fungus is occasionally found on the dead branches of the elm. The acervuli appear as little papillae over the surface of the bark. The conidia are hyaline, oval or obovate, 14-19 x 6-8μ.

THE GENUS MELANCONIUM

The genus Melanconium, consisting of over 100 described species contains a few common well known species, but most of them have been but little studied. The characters of this genus approach quite closely to those of the genus Gloeosporium with the exception of the color of the spores. While Gloeosporium spores are hyaline, Melanconium spores are dark colored. Setae are also

lacking, and the spores are typically straight. Only two species will be mentioned in this discussion. While there are a number of others described from woody branches of trees and shrubs in the United States, these are mostly uncommon or but little known.

Description of Species

Melanconium fuligineum (Scribn. & Viala) Cav. This fungus occurs on the fruit and perhaps the leaves of the cultivated grape, especially in the southern states. The fruit rots and dries up on the vines. The acervuli appear as small papillae over the fruit. The spores are slightly smoky in appearance, elliptical to oblong, 8-12 x 3.5-5μ. There seems to be some confusion regarding this fungus and *Gloeosporium fructigenum* on account of some similarity between the two. The spores of the Melanconium, however, are smaller and generally more pointed than those of the Gloeosporium and when mature show the smoky appearance.

Melanconium sacchari Massee. This fungus is found on dead pieces of sugar cane, and also occasionally on the living cane, in the Southern states. It produces the well known "Rind Disease" which is very serious in some places in the tropics. Sugar cane stalks affected with this fungus dry out rapidly, and the rather large black acervuli develop very abundantly on the rind tissue especially around the nodes. The spores (Figure 7) are dark brown, oval to

FIG. 7

Fig. 7. Spores of *Melanconium sacchari*

cylindrical, often guttulate, 10-12 x 4-6μ. The spores ooze out of the acervuli in black glistening masses or in long black strings, these sometimes being several centimeters long.

THE GENUS MARSSONIA

The genus Marssonia consists of about 80 described species, some of which are very common and well known. Most of the species in this genus are parasitic on leaves. This genus is in many ways very similar to Gloeosporium, the only real difference is that the spores are two-celled instead of continuous. The spores are

hyaline, stright or curved, and are borne on short crowded conidiophores in the acervulus. The different described species have never been worked over carefully, so only a few of the better known ones will be mentioned in this article.

Description of Species

Marssonia castagnei (Desm. and Mont.) Sacc. This fungus occurs very commonly on the leaves of the white poplar in the United States. The leaves are sometimes affected so seriously that many of them are shed. The spots formed, are somewhat circular and dark colored. A few small acervuli develop near the center of each spot, the spores oozing out of them in more or less whitish masses. The conidia (Figure 8) are hyaline, oblong clavate, slightly

FIG. 8

Fig. 8. Spores of *Marssonia castagnei*

constricted at the septum, 18-25 x 8-10μ. The ascogenous fungus, *Trochila populorum* Desm., is often found during the late winter in the old spots on the leaves and is probably the perfect stage of this Marssonia.

Marssonia juglandis (Lib.) Sacc. This fungus forms small circular or irregular spots on the leaves of walnut and butternut and is quite widely distributed throughout the United States. The conidia are fusoid, curved, with the apex somewhat pointed, 20-25 x 5μ. The ascogenous stage has been found and is known as *Gnomonia leptostyla* (Fr.) Ces. and De Not.

Marssonia martini Sacc. and Ellis. This fungus forms small circular spots on the leaves of some species of oaks. The acervuli develop abundantly near the center of the spots. The spores are fusoid, 12-15 x 2.5μ.

Marssonia ochroleuca B. & C. This fungus forms small circular spots on the leaves of the chestnut. This fungus is very similar to the preceding species.

THE GENUS PESTALOZZIA.

The genus Pestalozzia is a very large one, having over 200 described species. The forms of this genus are very common, though our knowledge of them is so slight that they are difficult to determine. Some of them are parasitic, but a great many are saphrophytic and are probably not confined to any one host. The acervuli have the same general structure as those of the previous genera. The spores (Figure 9) however, are very characteristic.

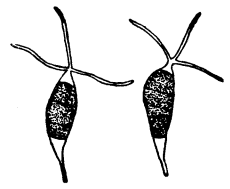

FIG. 9

Fig. 9. Spores of a Pestalozzia from a Leaf Spot on Sugar Cane

They are two to several septate and at least some of the cells are dark colored. Furthermore at the apex of the spore, there are two or more long, hyaline appendages or cilia. The acervuli always have a black appearance on account of the spores. As there are so many species, many of which have not been carefully worked over, it seems best only to mention a few of the more common forms.

Pestalozzia guepina Desm. This fungus occurs on the leaves of a number of different trees and shrubs and perhaps also some herbaceous plants. A variety of this species is also found on the cranberry. The acervuli are small and black. The conidia are about 20μ long and from three to four septate and have from three to four cilia or appendages.

Pestalozzia palmarum Cooke. This fungus is found on the leaves and fruits of various palms producing discolored spots. The conidia are fusiform, 4 septate and have three cilia. They average about 15 x 5-6μ.

Pestalozzia funerea Desm. This species also occurs on a wide range of hosts. It has been reported in this country on ginseng, appearing in a black velvety growth at the base of the leaves and flower stalks. The conidia are 4 septate, 22-32 x 6-8μ and have from two to five cilia.

Pestalozzia uvicola Speg. This fungus attacks the fruit of grapes in this country causing a rot. The conidia are 4 septate, 35 x 8-10μ, and have three cilia.

THE GENUS CORYNEUM.

The genus Cornyeum with over 90 described species, contains a few forms that are more or less common. This genus differs from the preceding genera in spore characters. The spores are two to several septate and dark colored. They also lack the cilia or appendages that are characteristic of the genus Pestalozzia. A few of the species are parasitic but a great many are probably only saprophytes. As with the other genera, many of the species are not well known. Only two species will be mentioned.

Coryneum beijerinckii Oud. This fungus forms spots on the leaves, fruits, and buds of the peach often causing considerable damage. Many of the young buds are killed. The acervuli are produced sparingly in the spots. The spores are dark colored, rather large, and from two to several septate.

Coryneum foliicolum Fuckel. This fungus forms spots on the leaves of a number of different trees. In this country, it is frequently reported on the leaves of the apple. The spores are for the most part 4 celled and from about 13-16.5 x 4-5.5μ.

THE GENUS CYLINDROSPORIUM.

The genus Cylindrosporium with over 100 described species contains a few forms that are very common and important. This genus differs from those previously described in the characters of the spores. The spores of Cylindrosporium are hyaline, long filiform, and generally continuous. The acervuli are subepidermal and light colored. Only two common species will be mentioned.

Cylindrosporium padi Karst. This fungus is found on the leaves of various stone fruits such as cherries and plums, producing the trouble generally known as the "Shot Hole" disease. Small reddish spots develop which later drop out leaving small circular holes in the leaf. Before the tissue drops out, however, the small acervuli develop and shed the spores. The spores are long filiform, curved, and measure about 48-60 x 2μ.

Cylindrosporium pomi Brooks. This fungus produces small spots or specks on the fruit of the apple. This trouble is very common in most of the apple districts of the country. The acervuli develop sparingly in these spots. The spores are hyaline, from one to five celled, variously curved, 15-80 x 2-2.5μ.

Literature

The literature dealing with the different species of the Melanconiales is very scattering. There are no monographs of any of the genera. The literature that is available is found mostly within scientific journals and Experiment Station bulletins. Below are given a few titles, including studies of a number of the different species in the different genera. Most of this literature is very easily obtained. Further references, if desired, can be found in the bibliographies given in these articles.

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